LHC Sequencer

Content:

1.1 What is the LHC Sequencer?

1.1.1 Definition

The LHC Sequencer is a high-level software application able to orchestrate a variety of LHC cycles in an automatic way under certain circumstances; or help the operators and physicist carry out the above work by providing guidance, and facilities to automate the procedures.

Every LHC cycle is a sequence made of several sub-sequences, and each sub-sequence is made of several tasks. Every sub-sequence is made of a large number of tightly coupled tasks that need to be executed in strict order and have to be performed successfully to allow the LHC machine to go from one sub-sequence to another.

Among the tasks to be managed are included:

- equipment state control;
- trigger the load of equipment settings;
- timing event request (start ramp etc.);
- instrumentation configuration;
- trigger beam measurements;
- trigger the coordinated data acquisition and saving.

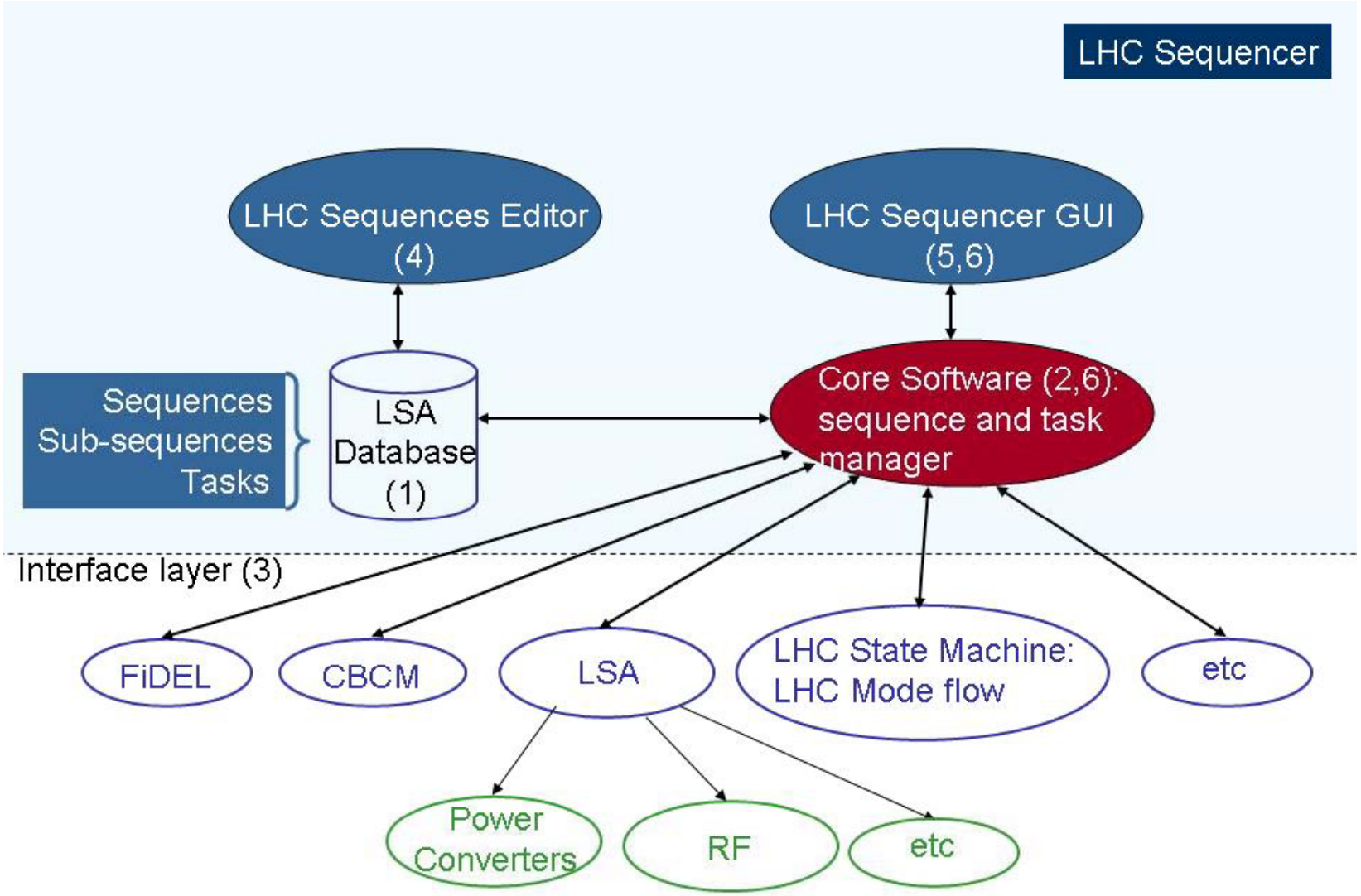
The sequencer has to monitor external signals and react accordingly.

1.1.2 Components

LHC Sequencer is an operation software tool that must:

1. allow the definition and persistent storage of sequences, sub-sequences and tasks;
2. allow a coordinated execution, and error and exception handling, of sequences, sub-sequences and tasks;
3. interface the appropriate LHC sub-systems encapsulating in this interface only the sub-system specific knowledge needed to operate the accelerator;
4. provide a graphical user interface (GUI) for sequences edition/definition/storage;
5. provide a GUI for sequences execution;
6. adequate the functionality and user interfaces to the different operation scenarios foreseen in the LHC accelerator: Machine Checkout, Beam Commissioning, Nominal Operation, Machine Development, etc.

This functionality gets translated into the following Sequencer components:


LHC Sequencer
LHC Sequences Editor (4)
LHC Sequencer GUI (5,6)
Sequences
Sub-sequences
Tasks
LSA Database (1)
Core Software (2,6): sequence and task manager
Interface layer (3)
FiDEL
CBCM
LSA
LHC State Machine: LHC Mode flow
etc
Power Converters
RF
etc

1.1.3 Interfaces

The following table presents a list of "possible" sub-systems the LHC Sequencer may interface. The symbol ✅ means that it is already interfaced within the current LHC Sequencer implementation.

Sub-system	Sub-system details	Interaction details
Power Converters ✅	1720 units	Consistent settings management; high-level control; status monitoring.
Magnets	- Dipoles - Quadrupoles - Sextupoles - Octupoles - Correctors	Quench Protection System (QPS) Post Mortem (PM): operational state monitoring, trigger special tests. Temperature and pressure monitoring via the Alarm system and fixed displays.
Injection septa and injection kickers	- Five septum magnets per Insertion Region (IR) - Four kicker magnets per IR	Consistent settings management; high-level control; status monitoring; injection quality checks via the Software Interlock System.
RF (Ring1 RF and Ring2 RF)	- Main 400 MHz - Staged 200 MHz Capture - Transverse Damping & Feedback System - Low-Level RF	Consistent settings management; status monitoring; timing; injection request; PM; trigger data acquisition.

Collimators for cleaning, dump and injection	- Primary collimators - Secondary collimators - Tertiary collimators (experimental insertions) - Collimators for injection protection - Collision debris collimators - Active absorbers - Scrapers ~ 100 collimators (phase 1)	T.B.D.
Beam Instrumentation	- Beam Position Monitors: 2x1032 - Beam Loss Monitors: > 3000 monitors - Beam Current Transformers - Transverse Profile Monitors (single pass, few pass-matching, synchrotron light and rest gas monitors and wire scanners) - Luminosity monitors - Tune, chromaticity and betatron coupling monitors - Aperture and non-linear monitors - Dedicated BPM - High Frequency pick-up - Schottky System	BI configuration, acquisition triggering (via timing events)

Beam Dump (one per Ring)	- 15 extraction kicker magnets - 15 steel septum magnets - Dilution kicker magnets - Beam Dump core - Diluter elements	Arm LBDS; manage operational states; manage timing events and tables, links/unlinks permit loops; sets number of turns at the LBDS hardware
Beam Flags		Safe Beam Flag - monitor and condition on Beam Presence Flag - monitor and condition on Safe Beam Parameters
Beam Interlock System		Status monitoring
Machine Protection System		Status monitoring
Quench Protection System		Status monitoring
Software Interlock System		Status monitoring
Alarms		Read Alarms
Cryogenics		Status monitoring
Vacuum		Status monitoring
Spectrometers Magnets (Power Converters)	Alice and LHCb	Consistent settings management; high-level control; status monitoring

Central Beam and Cycle Manager (CBCM)	- General Machine Timing - Beam Synchronous Timing	Send to the CBCM timing tables and timing events
FIDEL	(except if FIDEL interfaces directly the Magnet Control Software)	Trigger multipole corrections during the injection plateau, snap-back and ramp
Post-Mortem Analysis		Wait for completion of P.M. data transfer, wait for end of analysis
External Post Operation Checks (XPOC)		Management of operational states; dump configuration; trigger the load of timing tables for dump request and XPOC data acquisition
Management of Critical Settings (MCS)		
Access System		
Experiments (DIP: Data Interchange Protocol)		Inform the experiments via DIP about the current state of the machine and other information relevant for the experiments. Get experiments background.
Logbook		Add entries corresponding to main operational steps or other relevant information

2. Present status of the system

2.1 The current prototype already interfaces the following systems:

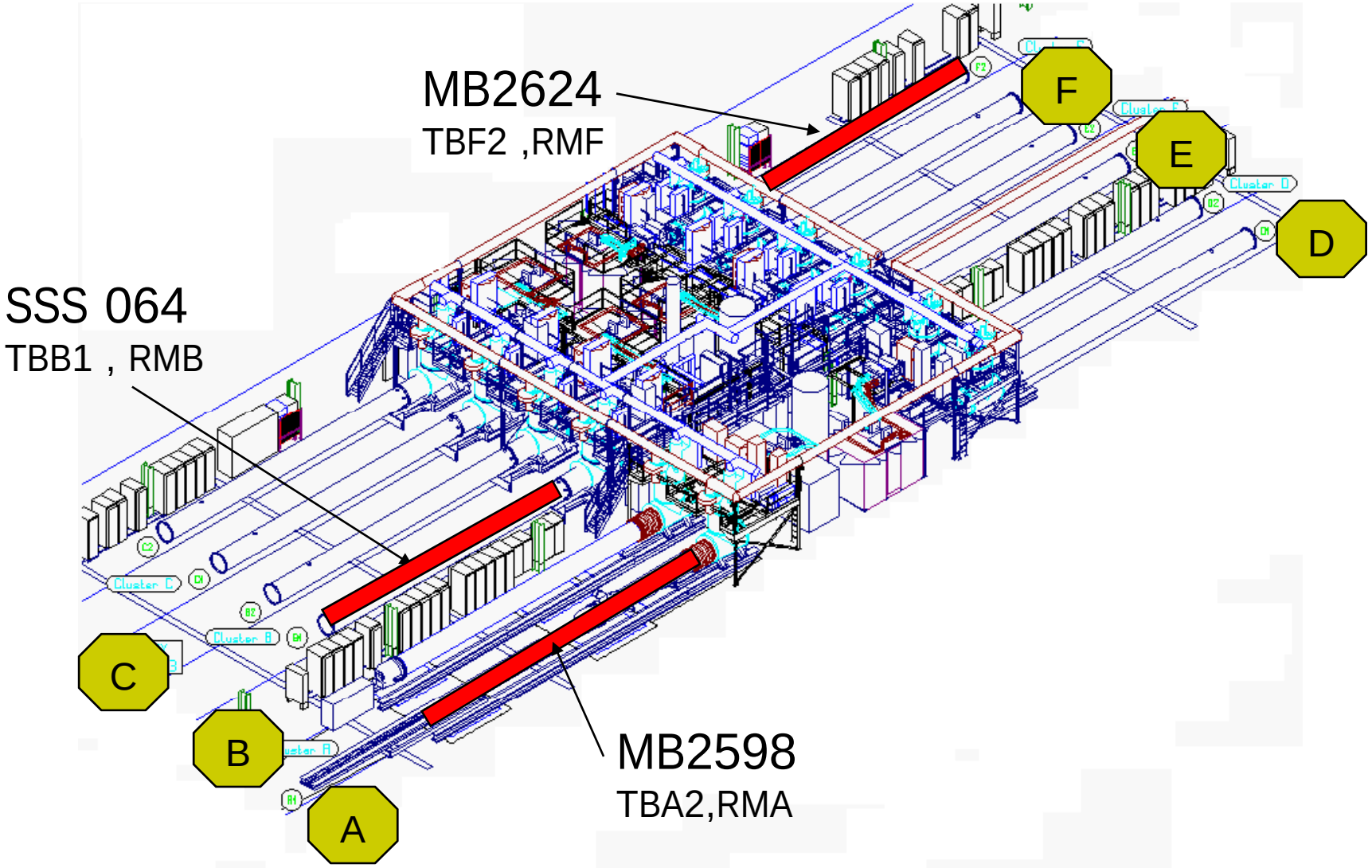
- LSA Explotation
- FiDEL
- Timing System (CBCM)
- LHC State Machine for Modes flow, through the package SMC

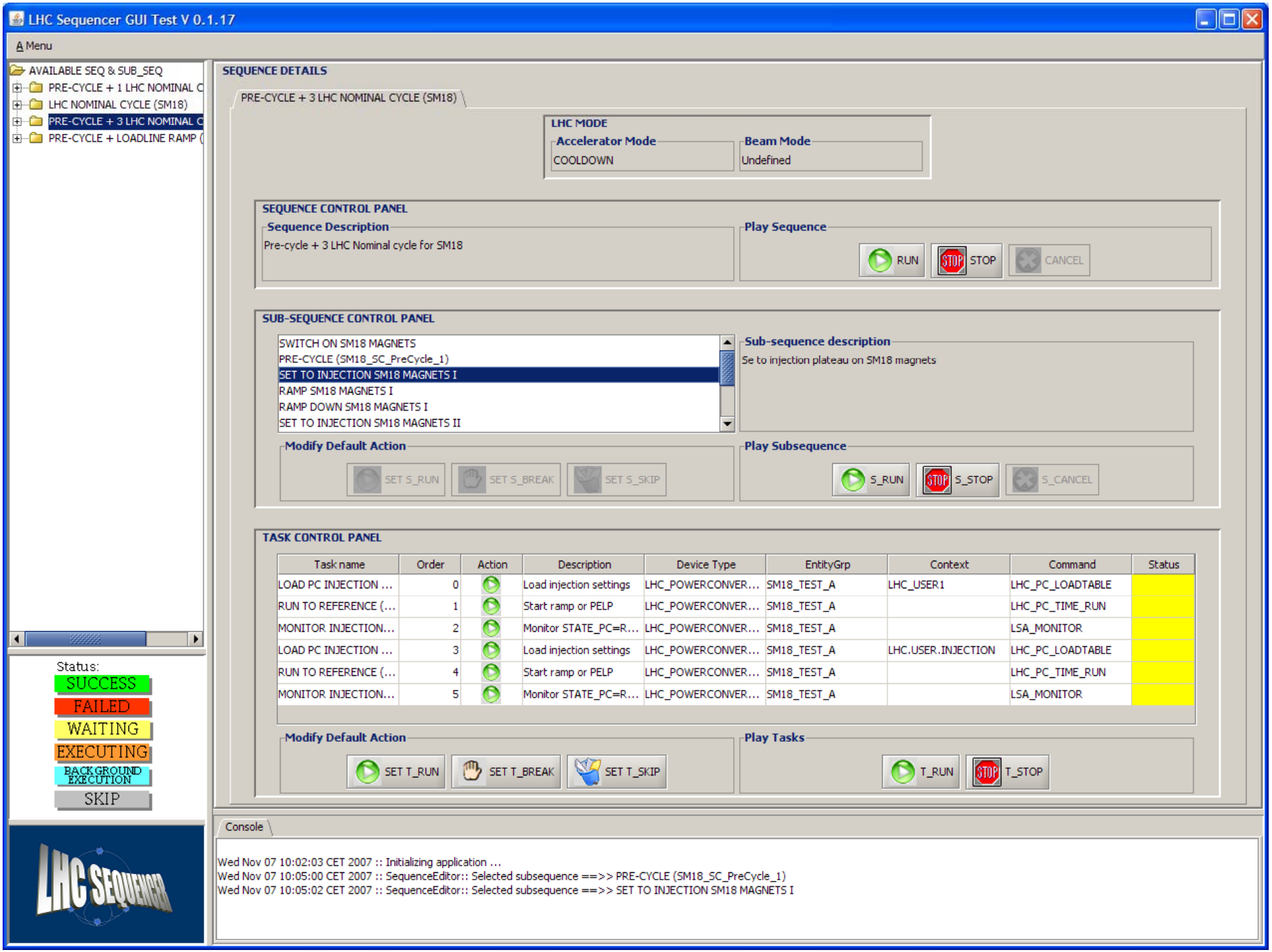
2.2 It is extensively used for driving the Sequences running in SM18:

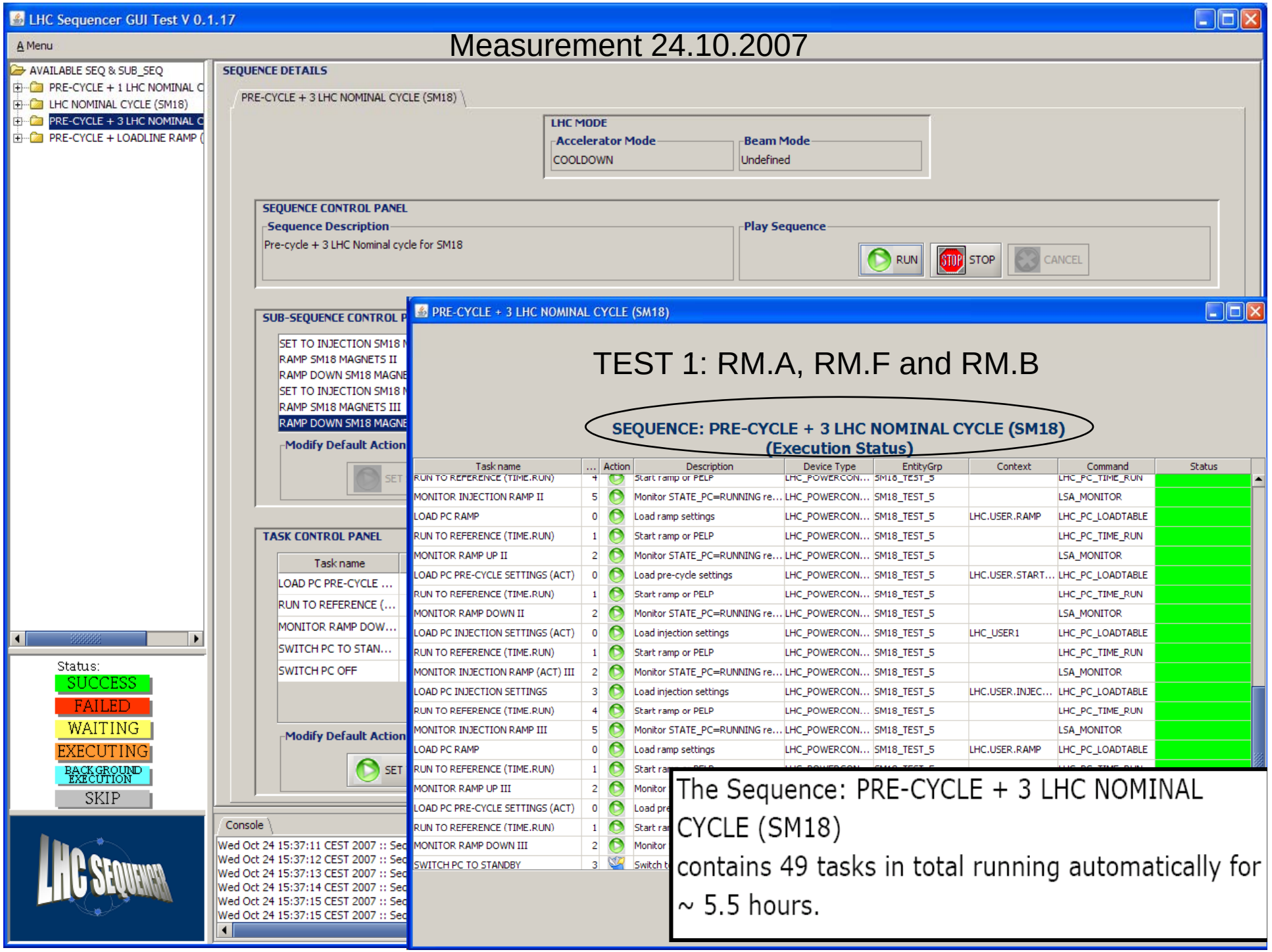
- PRE-CYCLE + 1 LHC NOMINAL CYCLE (SM18)
- LHC NOMINAL CYCLE (SM18)
- PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)
- PRE-CYCLE + LOADLINE RAMP (SM18)

The following file contains a snapshot of the current prototype driving two superconducting dipoles and one quadrupole in SM18 through the Sequence "PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)":

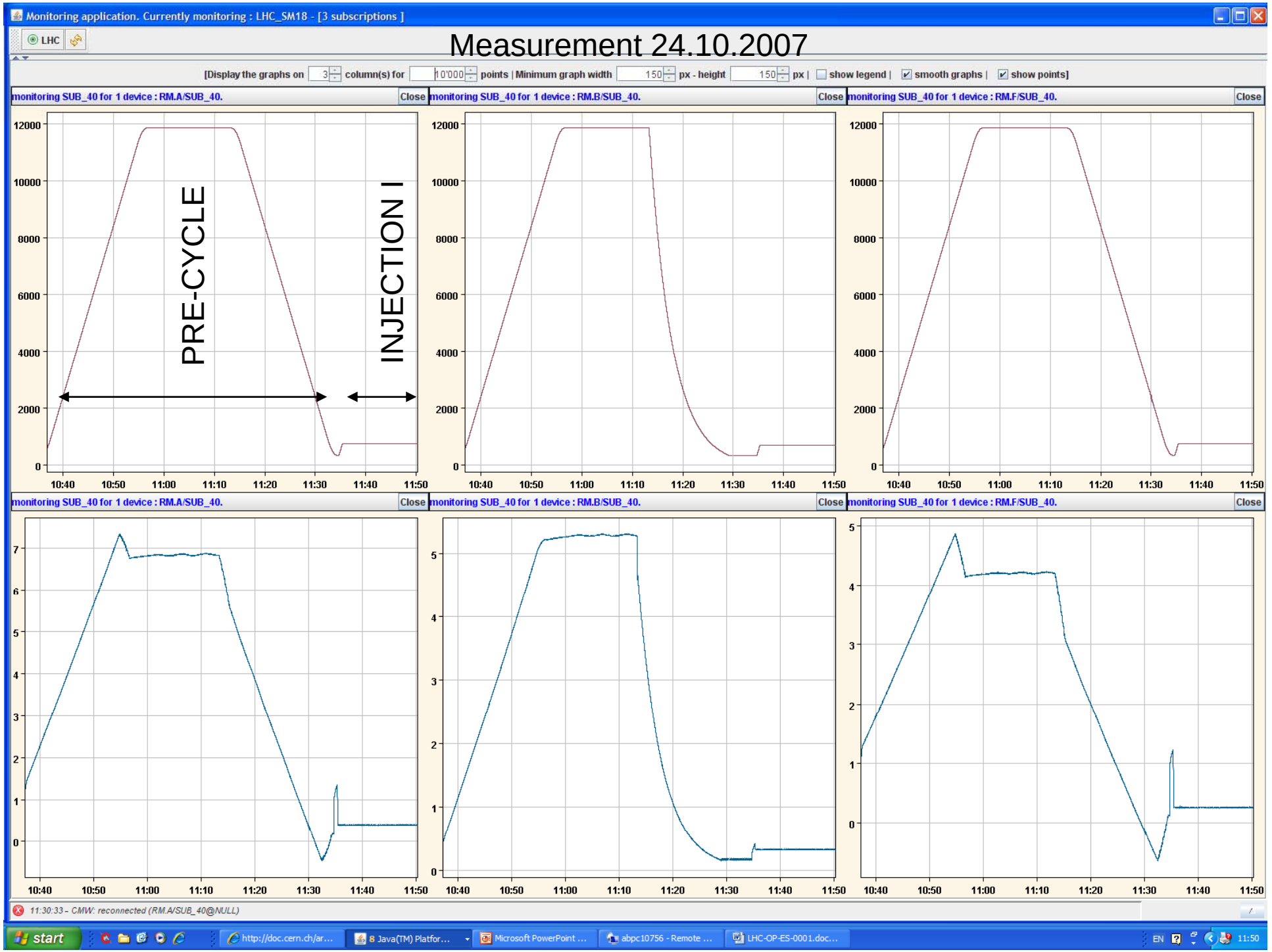
Test station situation @SM18

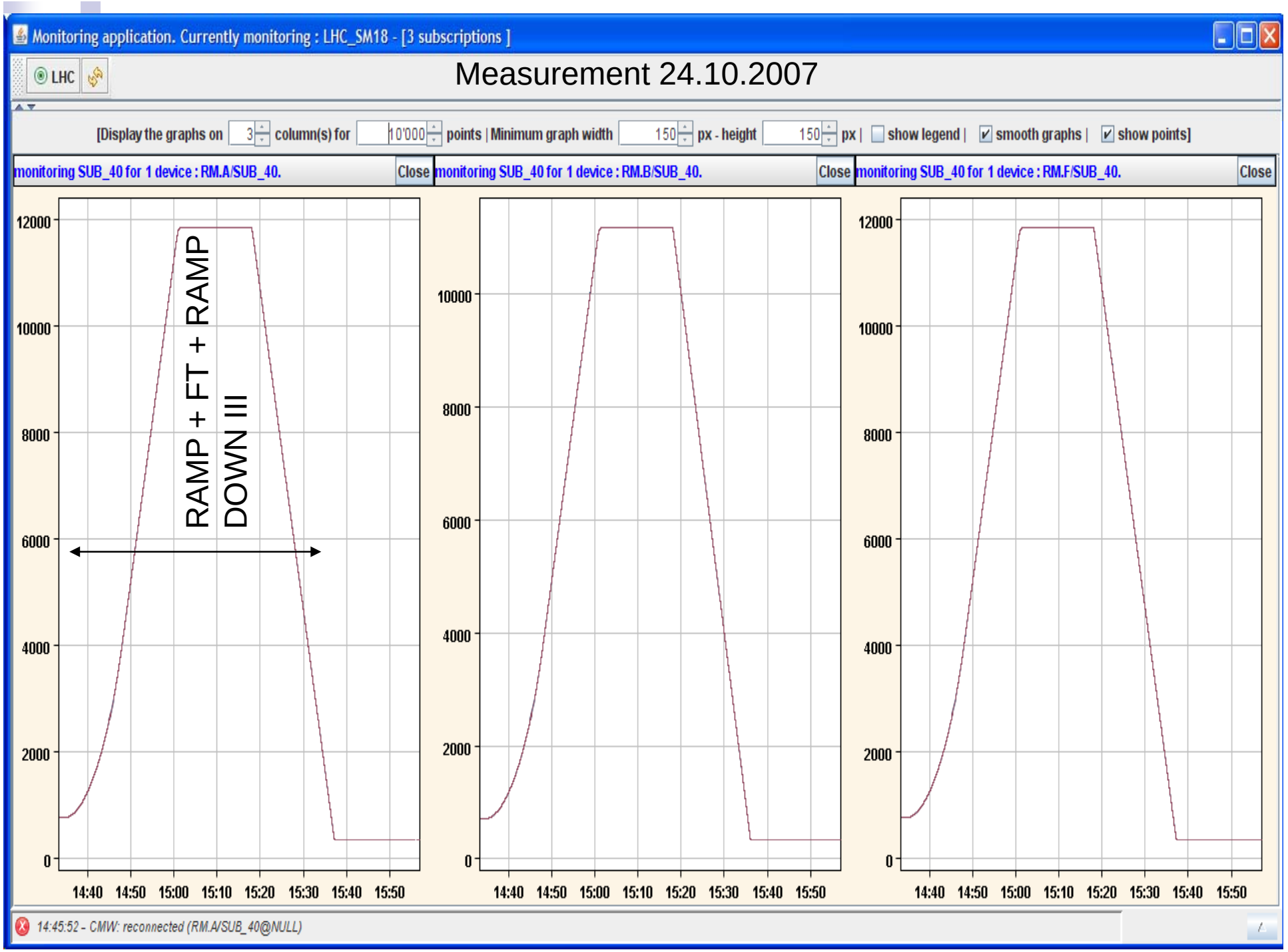



LHC Sequencer GUI Test V 0.1.17
Menu
AVAILABLE SEQ & SUB_SEQ
PRE-CYCLE + 1 LHC NOMINAL C
LHC NOMINAL CYCLE (SM18)
PRE-CYCLE + 3 LHC NOMINAL C
PRE-CYCLE + LOADLINE RAMP (
Status:
SUCCESS
FAILED
WAITING
EXECUTING
BACKGROUND EXECUTION
SKIP
LHC SEQUENCER
SEQUENCE DETAILS
PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)
LHC MODE
Accelerator Mode
COOLDOWN
Beam Mode
Undefined
SEQUENCE CONTROL PANEL
Sequence Description
Pre-cycle + 3 LHC Nominal cycle for SM18
Play Sequence
RUN
STOP
CANCEL
SUB-SEQUENCE CONTROL PANEL
SWITCH ON SM18 MAGNETS
PRE-CYCLE (SM18_SC_PreCycle_1)
SET TO INJECTION SM18 MAGNETS I
RAMP SM18 MAGNETS I
RAMP DOWN SM18 MAGNETS I
SET TO INJECTION SM18 MAGNETS II
Sub-sequence description
Se to injection plateau on SM18 magnets
Modify Default Action
SET S_RUN
SET S_BREAK
SET S_SKIP
Play Subsequence
S_RUN
S_STOP
S_CANCEL
TASK CONTROL PANEL
Task name | Order | Action | Description | Device Type | EntityGrp | Context | Command | Status
LOAD PC INJECTION ... | 0 | Load injection settings | LHC_POWERCONVER... | SM18_TEST_A | LHC_USER1 | LHC_PC_LOADTABLE
RUN TO REFERENCE (... | 1 | Start ramp or PELP | LHC_POWERCONVER... | SM18_TEST_A | | LHC_PC_TIME_RUN
MONITOR INJECTION... | 2 | Monitor STATE_PC=R... | LHC_POWERCONVER... | SM18_TEST_A | | LSA_MONITOR
LOAD PC INJECTION ... | 3 | Load injection settings | LHC_POWERCONVER... | SM18_TEST_A | LHC.USER.INJECTION | LHC_PC_LOADTABLE
RUN TO REFERENCE (... | 4 | Start ramp or PELP | LHC_POWERCONVER... | SM18_TEST_A | | LHC_PC_TIME_RUN
MONITOR INJECTION... | 5 | Monitor STATE_PC=R... | LHC_POWERCONVER... | SM18_TEST_A | | LSA_MONITOR
Modify Default Action
SET T_RUN
SET T_BREAK
SET T_SKIP
Play Tasks
T_RUN
T_STOP
Console
Wed Nov 07 10:02:03 CET 2007 :: Initializing application ...
Wed Nov 07 10:05:00 CET 2007 :: SequenceEditor:: Selected subsequence ==>> PRE-CYCLE (SM18_SC_PreCycle_1)
Wed Nov 07 10:05:02 CET 2007 :: SequenceEditor:: Selected subsequence ==>> SET TO INJECTION SM18 MAGNETS I


LHC Sequencer GUI Test V 0.1.17
Menu
Measurement 24.10.2007
AVAILABLE SEQ & SUB_SEQ
PRE-CYCLE + 1 LHC NOMINAL C
LHC NOMINAL CYCLE (SM18)
PRE-CYCLE + 3 LHC NOMINAL C
PRE-CYCLE + LOADLINE RAMP (
SEQUENCE DETAILS
PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)
LHC MODE
Accelerator Mode
COOLDOWN
Beam Mode
Undefined
SEQUENCE CONTROL PANEL
Sequence Description
Pre-cycle + 3 LHC Nominal cycle for SM18
Play Sequence
RUN
STOP
CANCEL
SUB-SEQUENCE CONTROL P
SET TO INJECTION SM18 M
RAMP SM18 MAGNETS II
RAMP DOWN SM18 MAGNE
SET TO INJECTION SM18 M
RAMP SM18 MAGNETS III
RAMP DOWN SM18 MAGNE
Modify Default Action
SET
TASK CONTROL PANEL
Task name
LOAD PC PRE-CYCLE ...
RUN TO REFERENCE (...
MONITOR RAMP DOW...
SWITCH PC TO STAN...
SWITCH PC OFF
Modify Default Action
SET
Status:
SUCCESS
FAILED
WAITING
EXECUTING
BACKGROUND EXECUTION
SKIP
LHC SEQUENCER
Console
Wed Oct 24 15:37:11 CEST 2007 :: Sec
Wed Oct 24 15:37:12 CEST 2007 :: Sec
Wed Oct 24 15:37:13 CEST 2007 :: Sec
Wed Oct 24 15:37:14 CEST 2007 :: Sec
Wed Oct 24 15:37:15 CEST 2007 :: Sec
Wed Oct 24 15:37:15 CEST 2007 :: Sec
PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)
TEST 1: RM.A, RM.F and RM.B
SEQUENCE: PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)
(Execution Status)
Task name | ... | Action | Description | Device Type | EntityGrp | Context | Command | Status
RUN TO REFERENCE (TIME.RUN) | 4 | Start ramp or PELP | LHC_POWERCON... | SM18_TEST_5 | | LHC_PC_TIME_RUN
MONITOR INJECTION RAMP II | 5 | Monitor STATE_PC=RUNNING re... | LHC_POWERCON... | SM18_TEST_5 | | LSA_MONITOR
LOAD PC RAMP | 0 | Load ramp settings | LHC_POWERCON... | SM18_TEST_5 | LHC.USER.RAMP | LHC_PC_LOADTABLE
RUN TO REFERENCE (TIME.RUN) | 1 | Start ramp or PELP | LHC_POWERCON... | SM18_TEST_5 | | LHC_PC_TIME_RUN
MONITOR RAMP UP II | 2 | Monitor STATE_PC=RUNNING re... | LHC_POWERCON... | SM18_TEST_5 | | LSA_MONITOR
LOAD PC PRE-CYCLE SETTINGS (ACT) | 0 | Load pre-cycle settings | LHC_POWERCON... | SM18_TEST_5 | LHC.USER.START... | LHC_PC_LOADTABLE
RUN TO REFERENCE (TIME.RUN) | 1 | Start ramp or PELP | LHC_POWERCON... | SM18_TEST_5 | | LHC_PC_TIME_RUN
MONITOR RAMP DOWN II | 2 | Monitor STATE_PC=RUNNING re... | LHC_POWERCON... | SM18_TEST_5 | | LSA_MONITOR
LOAD PC INJECTION SETTINGS (ACT) | 0 | Load injection settings | LHC_POWERCON... | SM18_TEST_5 | LHC_USER1 | LHC_PC_LOADTABLE
RUN TO REFERENCE (TIME.RUN) | 1 | Start ramp or PELP | LHC_POWERCON... | SM18_TEST_5 | | LHC_PC_TIME_RUN
MONITOR INJECTION RAMP (ACT) III | 2 | Monitor STATE_PC=RUNNING re... | LHC_POWERCON... | SM18_TEST_5 | | LSA_MONITOR
LOAD PC INJECTION SETTINGS | 3 | Load injection settings | LHC_POWERCON... | SM18_TEST_5 | LHC.USER.INJEC... | LHC_PC_LOADTABLE
RUN TO REFERENCE (TIME.RUN) | 4 | Start ramp or PELP | LHC_POWERCON... | SM18_TEST_5 | | LHC_PC_TIME_RUN
MONITOR INJECTION RAMP III | 5 | Monitor STATE_PC=RUNNING re... | LHC_POWERCON... | SM18_TEST_5 | | LSA_MONITOR
LOAD PC RAMP | 0 | Load ramp settings | LHC_POWERCON... | SM18_TEST_5 | LHC.USER.RAMP | LHC_PC_LOADTABLE
RUN TO REFERENCE (TIME.RUN) | 1 | Start ra
MONITOR RAMP UP III | 2 | Monitor
LOAD PC PRE-CYCLE SETTINGS (ACT) | 0 | Load pr
RUN TO REFERENCE (TIME.RUN) | 1 | Start ra
MONITOR RAMP DOWN III | 2 | Monitor
SWITCH PC TO STANDBY | 3 | Switch t
The Sequence: PRE-CYCLE + 3 LHC NOMINAL CYCLE (SM18)
contains 49 tasks in total running automatically for ~ 5.5 hours.

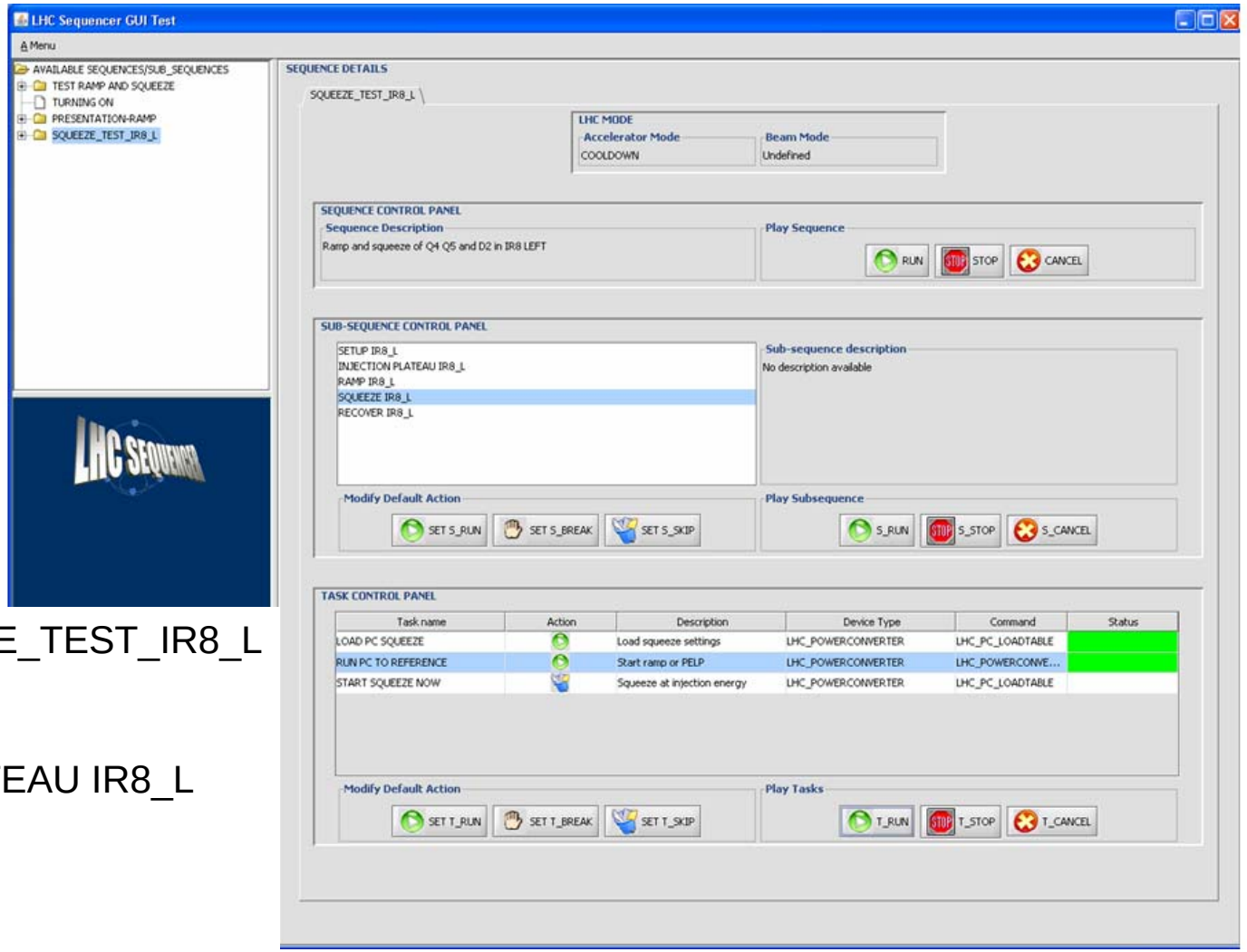
Measurement 24.10.2007




Monitoring application. Currently monitoring : LHC_SM18 - [3 subscriptions]
LHC
Measurement 24.10.2007
[Display the graphs on 3 column(s) for 10'000 points | Minimum graph width 150 px - height 150 px | show legend | smooth graphs | show points]
monitoring SUB_40 for 1 device : RM.A/SUB_40.
Close
monitoring SUB_40 for 1 device : RM.B/SUB_40.
Close
monitoring SUB_40 for 1 device : RM.F/SUB_40.
Close
RAMP + FT + RAMP DOWN III
12000
10000
8000
6000
4000
2000
0
14:40
14:50
15:00
15:10
15:20
15:30
15:40
15:50
14:45:52 - CMW: reconnected (RM.A/SUB_40@NULL)

2.3 Commissioning of LHCb dipole and compensators

2.4 Ramp and Squeeze of D2, Q4 & Q5 during HWC of Sector 78

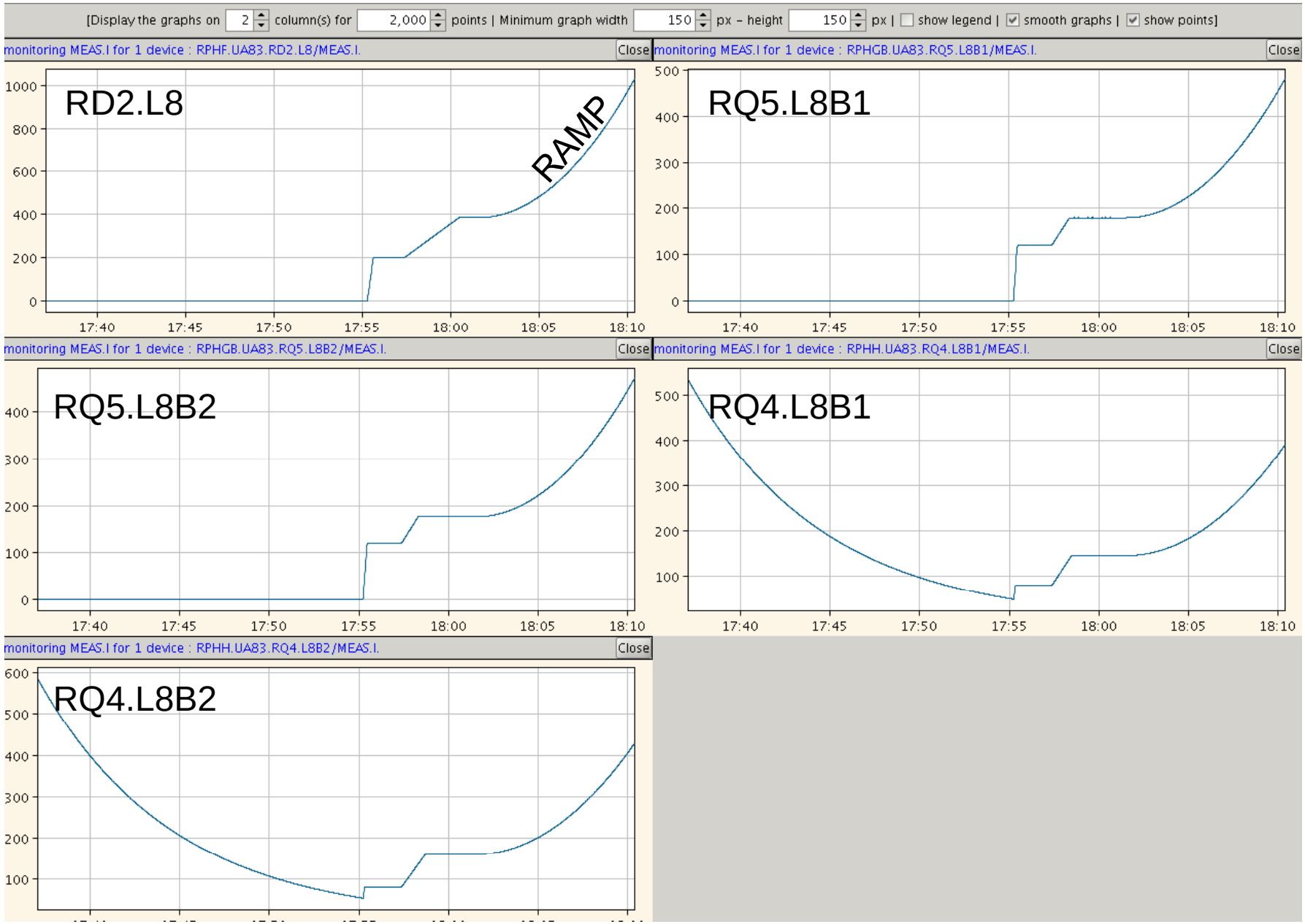


Sequence: SQUEEZE_TEST_IR8_L

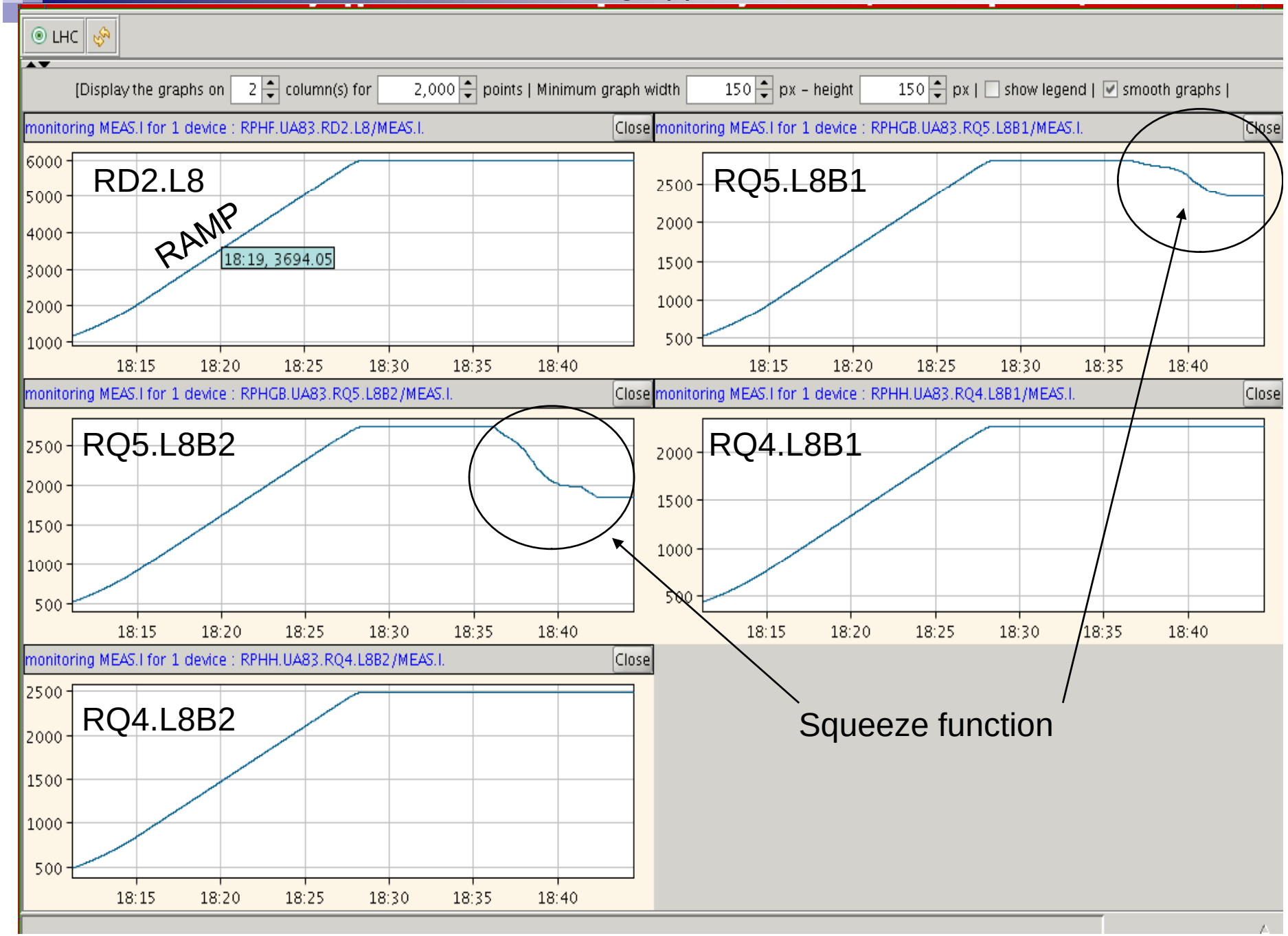
Sub-sequences:

1. SETUP IR8_L
2. INJECTION PLATEAU IR8_L
3. RAMP IR8_L
4. SQUEEZE IR8_L
5. RECOVER IR8_L

Monitoring Application



Monitoring Application



3.1 What are the requirements that must be implemented in the software?

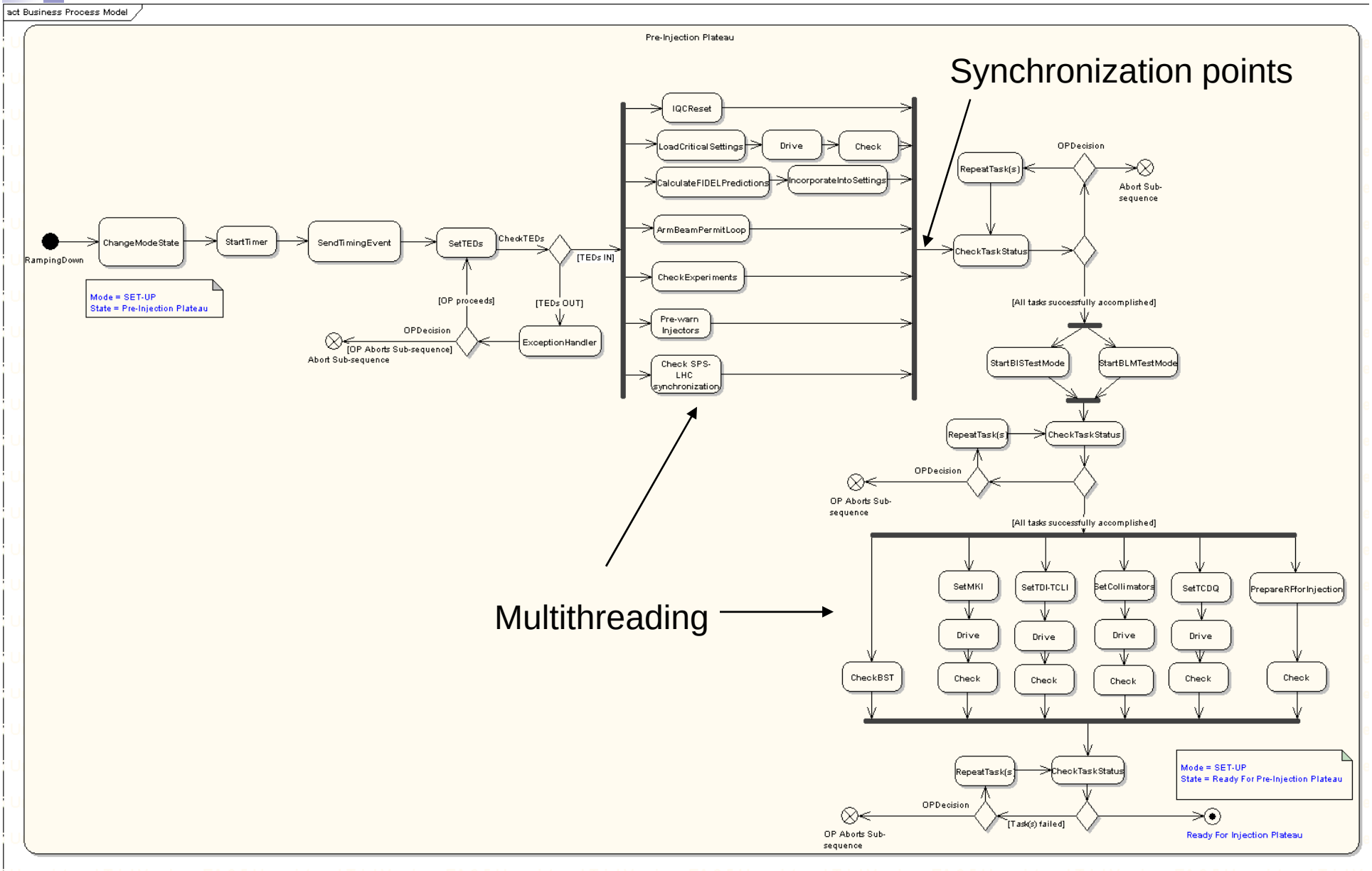
must be present for **Machine Checkout**

must be present for **Beam Commissioning**

A. Task Management

	No.	Requirement
	TM.R0	The sequencer shall **never initiate a task that is incompatible with the status of the beam flags, BIC, beam dump, etc**.
	TM.R1	The sequencer should be able to initiate **tasks in parallel. Handle multithreading/distributed processing logic/asynchronous communication**. The sequencer also has to manage the life-cycle of these parallel tasks after launching them, i.e. check their progress, wait for them to finish, cancel them, etc.

		Also, the sequencer has to *provide synchronization points*to wait until all tasks of a series have finished before continuing the sequence.
	TM.R3	Allow operator to **manually** execute and tasks.
	TM.R4	Allow operator to **skip tasks safely**.
	TM.R5	The sequencer should **provide facilities to define the appropriate reaction** when a task doesn't execute normally, e.g. stop, continue, issue warning, abort, start a recovery procedure, etc.
	TM.R6	**Define clearly the tasks that the operator can restart safely and the ones that cannot be restarted requiring a different recover procedure to be followed**. The sequencer should enforce this and prevent users from restarting commands that should not be restarted.
	TM.R7	Allow operator to **manually abort executing task(s) safely**. The abort procedure will depend on the current state of the machine, but in general could be: stop execution or take some more specific action (e.g. ramp off, go to a safe state, execute a recovery sequence, etc.)
	TM.R8	**Protection against tasks executed outside the LHC Sequencer context**, for example, from equipment expert applications.



B. Sequence Manager

	No.	Requirement
★	SQ.R0	Is able to accept external input from monitoring or machine protection process and modify behavior appropriately. These external inputs shall
		include the Beam Presence Flag, the Safe Beam Flag, the Safe Beam Parameters, the Beam Interlocks, the beam dump status. Suggestions on what to do if an external event happens: • interrupt execution of sequence, and let the operator decide what to do next and whether to resume; • automatic execution of an appropriate (recovery) sequence. • possibility to specify behavior upon receiving an event.

	SQ.R1	It should be possible to register a sequence that must be loaded and executed automatically or upon operator request, depending on the type of error(s) issued during the sequence execution, or the type of external events received by the Sequencer. For example, if only one of the beams is dumped, the sequence to keep running one beam only may be quite different, so the sequencer should be able to load automatically and play the new sequence.
	SQ.R2	Allow re-use of sub-sequences in different sequences.
	SQ.R3	Allow operator to manually drive the sequence. This requirement is linked to TM.R3.
	SQ.R4	Allow operator to manually drive a sequence for a given sub-system e.g. step-by-step execution, run-to-breakpoint, etc.
	SQ.R5	Allow operator to manually abort the sequence safely. This requirement is linked to TM.R7.
	SQ.R6	A possible crash of the LHC Sequencer should not affect operations. A possibility is that

		the application restarts automatically, checks the status of all the sub-systems (including external events) and displays the current state of the accelerator. In particular, it should not force operations to restart an ongoing sequence.
	SQ.R7	TM.R6
	SQ.R8	Recovery procedures should be defined with the possibility to run them automatically or to be used to guide the operators.
	SQ.R9	Tool to validate sequences and timing tables. We could foresee a series of well defined rules that the sequences and timing tables have to satisfy to assure a reliable operation.

C. LHC Sequences Editor

	No.	Requirement
★	SE.R0	Support multiple sequence definitions.
★	SE.R1	Interface a persistent storage medium (the chosen technology should be transparent for the user).
★	SE.R2	Allow re-use of sub-sequences in different sequences (SQ.R2), and tasks in different sub-sequences.
★	SE.R3	Sequences should be easily configurable - add/delete/copy/change task specification. [Is this always true or only in debugging (commissioning/MD) mode? Who is allowed to define LHC Sequences?]

D. LHC Sequencer GUI

	No.	Requirement
★	GU.R1	For security, only the commands that can be currently issued by the operator will appear activated on the window and can

		be clicked with the mouse. The active commands will depend on the current Sequencer state.
	GU.R2	Display progress and status of executing tasks (by displaying logging output both on the window console and in a log file/ a database).
	GU.R3	A convention should be established on the colour code for error, warnings, success, etc.
	GU.R4	Requirements TM.R3, TM.R4, TM.R5, TM.R7, SQ.R3, SQ.R4, and SQ.R5 also applied to the GUI.
	GU.R5	Allow operator to mask errors safely.
	GU.R6	Pop-up messages of warning to ask the Operator to confirm that a given task or action has been done before continuing the sequence execution.
	GU.R7	Different user's levels, e.g. a super-user have access to more flexibility in the GUI than a normal user.

3.2 What else?

1. The **Sequences we'll need for Machine Checkout should be defined**:
   a. LHC Nominal Injection Sub-sequence (work on going)
   b. LHC Nominal Sequence
   c. Inject and Dump (work on going)
   d. Circulate and Dump
   e. Others
   f. Failure recovery sequences
2. The Sequences have to be configurable **to be played by equipment, by powering sub-sector, by sector** (already possible via the HW_GRP if the equipment/system is in the LSA database).

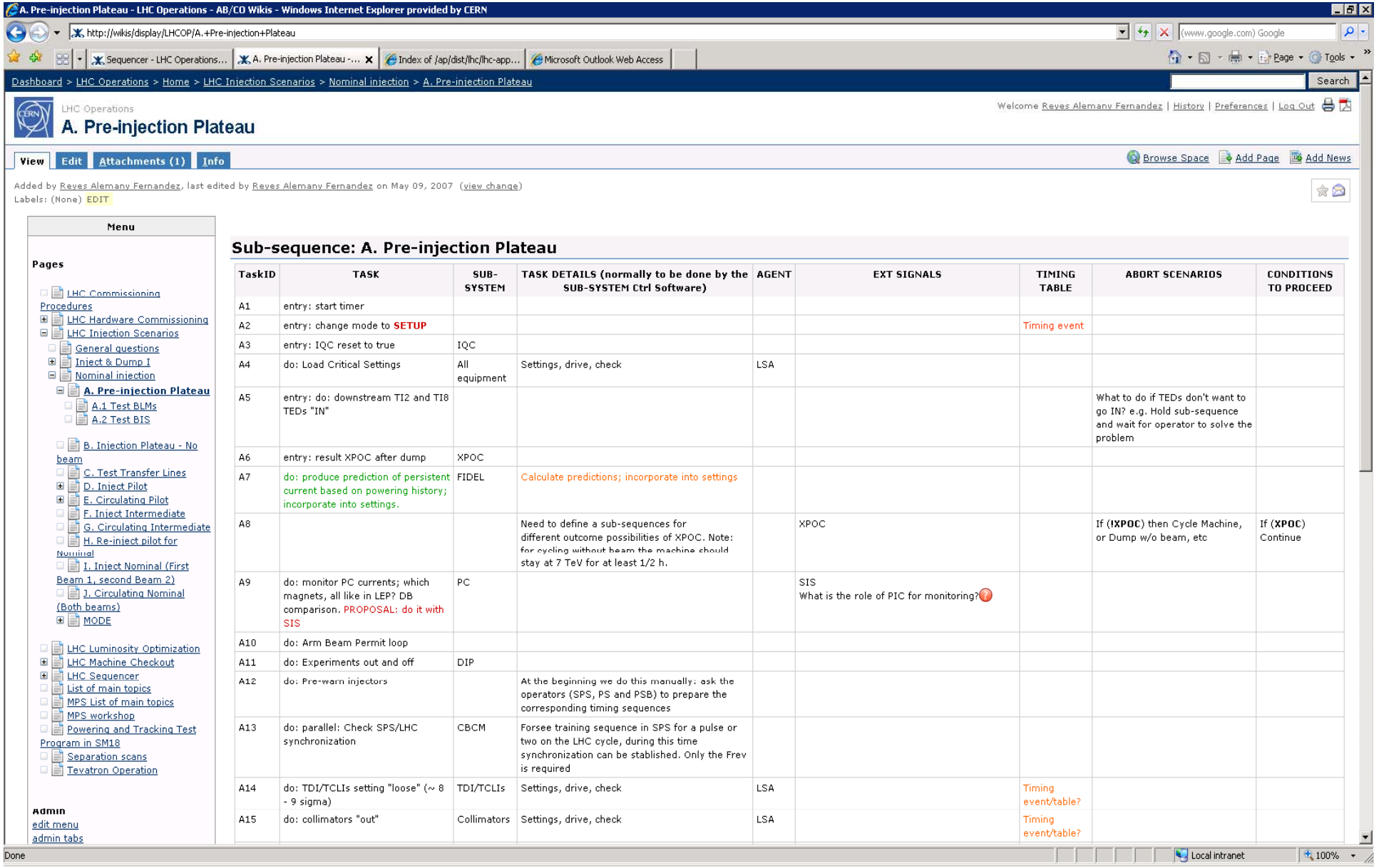
4. What do we get when this phase is finished

- If we can perform a dry run with the full machine, then we can say we are ready for beam commissioning.

- If some sub-systems are missing, then we should be able to simulate them to carry on.

Nominal Injection

MODE	SUB-SEQUENCE
SET-UP	
	A. Pre-injection Plateau
	B. Injection Plateau - No beam
	C. Test Transfer Lines
INJECTION PILOT	
	D. Inject Pilot
	E. Circulating Pilot
INJECTION INTERMEDIATE	
	F. Inject Intermediate
	G. Circulating Intermediate
INJECTION NOMINAL	
	H. Re-inject pilot for Nominal
	I. Inject Nominal (First Beam 1, second Beam 2)
	J. Circulating Nominal (Both beams)



Sub-sequence: A. Pre-injection Plateau

TaskID	TASK	SUB-SYSTEM	TASK DETAILS (normally to be done by the SUB-SYSTEM Ctrl Software)	AGENT	EXT SIGNALS	TIMING TABLE	ABORT SCENARIOS	CONDITIONS TO PROCEED
A1	entry: start timer							
A2	entry: change mode to **SETUP**					Timing event		
A3	entry: IQC reset to true	IQC						
A4	do: Load Critical Settings	All equipment	Settings, drive, check	LSA				
A5	entry: do: downstream TI2 and TI8 TEDs "IN"						What to do if TEDs don't want to go IN? e.g. Hold sub-sequence and wait for operator to solve the problem	
A6	entry: result XPOC after dump	XPOC						
A7	do: produce prediction of persistent current based on powering history; incorporate into settings.	FIDEL	Calculate predictions; incorporate into settings					
A8			Need to define a sub-sequences for different outcome possibilities of XPOC. Note: for cycling without beam the machine should stay at 7 TeV for at least 1/2 h.		XPOC		If (**!XPOC**) then Cycle Machine, or Dump w/o beam, etc	If (**XPOC**) Continue
A9	do: monitor PC currents; which magnets, all like in LEP? DB comparison. PROPOSAL: do it with SIS	PC			SIS What is the role of PIC for monitoring?			
A10	do: Arm Beam Permit loop							
A11	do: Experiments out and off	DIP						
A12	do: Pre-warn injectors		At the beginning we do this manually: ask the operators (SPS, PS and PSB) to prepare the corresponding timing sequences					
A13	do: parallel: Check SPS/LHC synchronization	CBCM	Forsee training sequence in SPS for a pulse or two on the LHC cycle, during this time synchronization can be stablished. Only the Frev is required					
A14	do: TDI/TCLIs setting "loose" (~ 8 - 9 sigma)	TDI/TCLIs	Settings, drive, check	LSA		Timing event/table?		
A15	do: collimators "out"	Collimators	Settings, drive, check	LSA		Timing event/table?		

Admin
edit menu
admin tabs

A14	do: TDI/TCLIS setting "loose" (~ 8 - 9 sigma)	TDI/TCLIS	Settings, drive, check	LSA		Timing event/table?		
A15	do: collimators "out"	Collimators	Settings, drive, check	LSA		Timing event/table?		
A16	do: TCDQ setting "loose" (~ 8 - 9 sigma)	TCDQ	Settings, drive, check	LSA		Timing event/table?		
A17	do: prepare RF for Injection	RF	1.) RF low level: set frequency to injection level; set gain of phase loop amplifier; set gain and time constant of the synchronisation loop amplifier 2.) do: reset the revolution frequency generator 3.) do: close the phase loop around the VCO 4.) do: 400 MHz system: RF drive on, phase loop to cavity sum signal 5.) do: RF transverse damper: operational Beam specific settings LATER?				What to do if RF fails?	
A18	do: set MKIs to standby	MKI	Settings, drive, check. How much time is needed? (Etiennet Carlier) (If too long, make this On Entry)	LSA	Listen and verify: pre-pulse transmission and timing (in principle exits an interlock in the kicker timing. If it is not OK we don't get the "Injection Permit" signal)			
A19	do: check BST operational	CBCM	How? Listener?					

Optional Sub-sequences that can be played in Pre-injection Plateau:

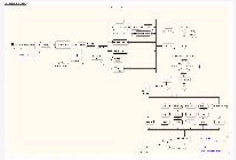
Sub-sequence: A.1 Test BLMs

A.1 Test BLMs

Sub-sequence: A.2 Test BIS

A.2 Test BIS

UML Activity Diagram



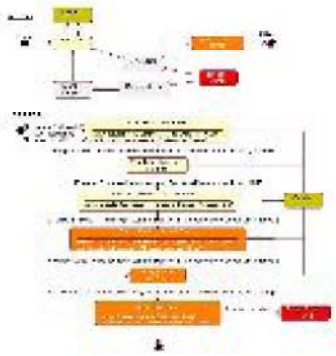
2 children | View in hierarchy

0 comments | Add Comment

Inject & Dump

MODE	SUB-SEQUENCE
SETUP	
	A. Pre-injection Plateau
	L. Injection Plateau - No beam I&D
INJECT AND DUMP	
	M. Prepare Inject & Dump
	N. Inject & Dump

MODE and STATE MACHINE flow (click on the picture):



6. Beam requirements

The hardware commissioning and machine checkout periods are an extremelly useful testbench for the Sequencer. However, the software won't be fully validated until we have beam in the machine. Unavoidable, some Sequencer commissioning time with beam! will be needed.

7. References

1. LHC-CQ-ES-0001 "LHC Sequencer - Operational functionality, interfaces and requirements"
2. LHC Injection Scenarios
3. Software: cvs under lhc/lhc-app-sequencer
4. Software can be run from here (and the LHC Consol Manager)

Conclusions

- Within the LHC Sequencer framework there are three different areas of activities:
  - Software implementation of the requirements (LHC-CQ-ES-0001)
  - Interface of the sub-systems
  - Sequences, sub-sequences and tasks definition
- Work is going on for the three of them
- All the sub-systems “available” so far have being integrated already
- We have gained invaluable experience with the already performed tests (SM18, Exp. Magnets, Sector 78)
- But we need to proceed with the integration of other systems a.s.a.p. even before Checkout starts